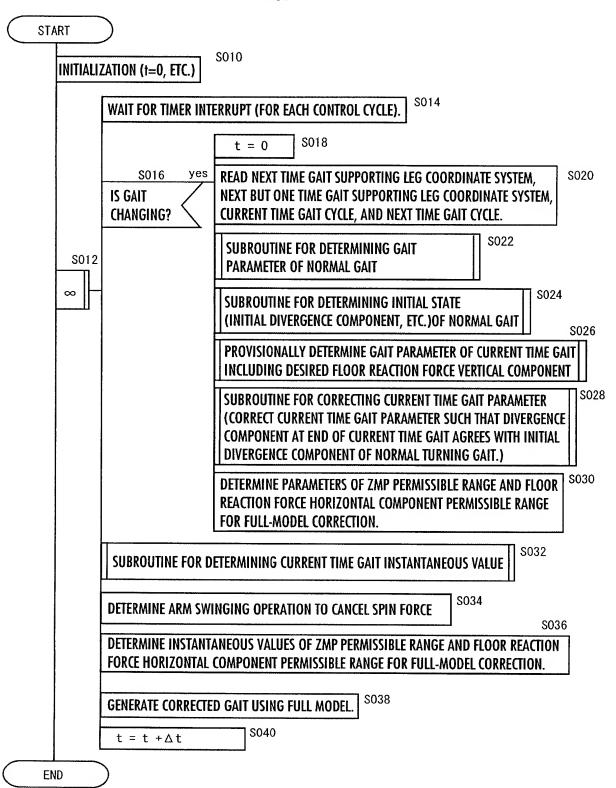


REPLACEMENT

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FIG.10



S024

ENTRY

11/19

FIG.12

S200 DETERMINE INITIAL STATES (STATES AT INITIAL TIME Ts) OF FOOT POSITION/POSTURE, BODY POSTURE ANGLE $\, heta$ bs, and arm postures on the basis of normal turning gait parameter. S202 PROVISIONALLY DETERMINE INITIAL (AT Ts) BODY HORIZONTAL POSITION, VELOCITY, ANGULAR VELOCITY, AND BODY INCLINATION RESTORING MOMENT ZMP-CONVERTED VALUE PEAK VALUE CANDIDATES (Xs, Vxs, ω bs, ZMPrecpeak). S206 DETERMINE INITIAL BODY VERTICAL POSITION/VELOCITY (Zs, Vzs). S208 USING DYNAMIC MODEL, GENERATE GAIT FOR ON STEP ON THE BASIS OF NORMAL TURNING GAIT PARAMETER INCLUDING ZMPrecpeak, TAKING θ bs,(Xs, Vxs, ω bs), (Zs,Vzs) AS INITIAL STATES OF BODY. S210 CONVERT TERMINAL BODY HORIZONTAL POSITION, VELOCITY, POSTURE ANGLE, AND ANGULAR VELOCITY OF GENERATED GAIT INTO VALUES OBSERVED FROM SUPPORTING LEG COORDINATE SYSTEM OF NEXT STEP, AND DENOTE THE VALUES BY (Xe, Vxe, θ be, ω be). S212 BOUNDARY CONDITION ERRORS (errx, errv, err θ , err ω) S204 = (Xs, Vxs, θ bs, ω bs)-(Xe, Vxe, θ be, ω be) yes ∞ LEAVE REPETITION LOOP. ARE ALL errx, erry, err θ b. AND err ω b WITHIN PERMISSIBLE RANGES? S216 DETERMINE A PLURALITY OF CANDIDATES ($Xs + \triangle Xs$, Vxs, ωbs , ZMPrecpeak), (Xs, $Vxs + \Delta Vxs$, ω bs, ZMPrecpeak), (Xs, Vxs, ω bs $+ \Delta \omega$ bs, ZMPrecpeak). (Xs, Vxs, ω bs, ZMPrecpeak+ \triangle ZMPrecpeak) IN THE VICINITY OF (Xs, Vxs, ω bs, ZMPrecpeak), AND BASED ON THEM, DETERMINE BOUNDARY CONDITION ERROR CORRESPONDING TO EACH OF THEM AS DESCRIBED ABOVE. **S218** DETERMINE NEW CANDIDATES (Xs, Vxs, ω bs, ZMPrecpeak) ON THE BASIS OF BOUNDARY CONDITION ERRORS CORRESPONDING TO (Xs. Vxs. abs. ZMPrecpeak) AND EACH OF CANDIDATES IN THE VICINITY THEREOF. DETERMINE INITIAL BODY HORIZONTAL POSITION, VELOCITY, POSTURE ANGLE, AND ANGULAR VELOCITY S220 (XO, VxO, θ bO, ω bO), INITIAL BODY VERTICAL POSITION AND VELOCITY (ZO, VzO), AND INITIAL BODY POSTURE ANGLE AND ANGULAR VELOCITY AT ORIGINAL INITIAL TIME O. **S222** DETERMINE NORMAL TURNING INITIAL DIVERGENCE COMPONENT q[0] ACCORDING TO THE FOLLOWING EXPRESSION. $q[0] = X0 + Vx0 / \omega 0$ DETERMINE q'', WHICH IS THE VALUE OF NORMAL TURNING INITIAL DIVERGENCE COMPONENT q[0]**S224**

DETERMINE q", WHICH IS THE VALUE OF NORMAL TURNING INITIAL DIVERGENCE COMPONENT q[0] OBSERVED FROM SUPPORTING LEG COORDINATE SYSTEM OF CURRENT TIME GAIT, AND (ZO", VzO"), WHICH ARE VALUES OF INITIAL BODY VERTICAL POSITION AND VELOCITY OBSERVED FROM SUPPORTING LEG COORDINATE SYSTEM OF CURRENT TIME GAIT.

REPLACEMENT

16/19

FIG.17

S028

ENTRY

S700

PROVISIONALLY DETERMINE ZMP CORRECTION PARAMETER CANDIDATE a AND BODY INCLINATION RESTORING MOMENT ZMP-CONVERTED VALUE PEAK VALUE CANDIDATES (ZMPrecpeaka, ZMPrecpeakb).

S704

S706

CALCULATE PROVISIONAL CURRENT TIME GAIT UNTIL TERMINATING TIME ON THE BASIS OF PARAMETER OBTAINED BY CORRECTING ZMP PARAMETER, WHICH HAS BEEN PROVISIONALLY DETERMINED BY PROVISIONAL DETERMINATION PROCESSING OF CURRENT TIME GAIT PARAMETER, BY ZMP CORRECTION PARAMETER CANDIDATE a, BODY INCLINATION RESTORING MOMENT ZMP-CONVERTED VALUE PEAK VALUE CANDIDATES (ZMPrecpeaka, ZMPrecpeakb), AND OTHER CURRENT TIME GAIT PARAMETERS.

DETERMINE TERMINAL DIVERGENCE COMPONENT q0[k] ACCORDING TO THE FOLLOWING EXPRESSION FROM BODY POSITION/VELOCITY (Xe, Ve) AT TERMINATING END OF CURRENT TIME GAIT:

 $q0[k] = Xe + Vxe / \omega 0$

DETERMINE TERMINAL DIVERGENCE COMPONENT ERROR error **ACCORDING TO THE FOLLOWING EXPRESSION:**

errq = q0[k] - q''

S708

TERMINAL BODY POSTURE ANGLE ERROR θ berr

= NORMAL GAIT INITIAL BODY POSTURE ANGLE

- CURRENT TIME GAIT TERMINAL BODY POSTURE ANGLE

TERMINAL BODY POSTURE ANGULAR VELOCITY ERROR ω berr

= NORMAL GAIT INITIAL BODY POSTURE ANGULAR VELOCITY

- CURRENT TIME GAIT TERMINAL BODY POSTURE ANGULAR VELOCITY

S702

∞

S712 yes

LEAVE REPETITION LOOP.

ARE ALL errg. θ berr. AND ω berr

WITHIN PERMISSIBLE RANGES?

S714

S710

DETERMINE A PLURALITY OF CANDIDATES ($a + \triangle a$, ZMPrecpeaka, ZMPrecpeakb),

- (a, ZMPrecpeaka+ △ ZMPrecpeaka, ZMPrecpeakb), AND
- (a, ZMPrecpeaka, ZMPrecpeakb+ △ ZMPrecpeakb) IN THE VICINITY OF
- (a, ZMPrecpeaka, ZMPrecpeakb), AND BASED ON THEM, DETERMINE ERROR CORRESPONDING TO EACH OF THEM AS DESCRIBED ABOVE.

DETERMINE NEW PARAMETER CANDIDATES (a, ZMPrecpeaka, ZMPrecpeakb) ON THE BASIS OF (a, ZMPrecpeaka, ZMPrecpeakb) AND ERROR CORRESPONDING TO EACH OF CANDIDATES IN THE VICINITY THEREOF.

S716

FIG. 19
BODY INCLINATION RESTORING MOMENT ZMP-CONVERTED VALUE OF NORMAL GAIT (ZMPrec)

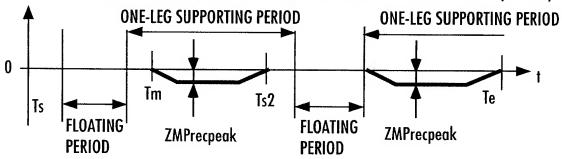


FIG.20

BODY INCLINATION RESTORING MOMENT ZMP-CONVERTED VALUE OF CURRENT TIME GAIT (ZMPrec)

